ME 3550

INSTRUCTION MANUAL

EMR MODELS 223B AND 223G
SOLID-STATE POWER SUPPLY

Revision E

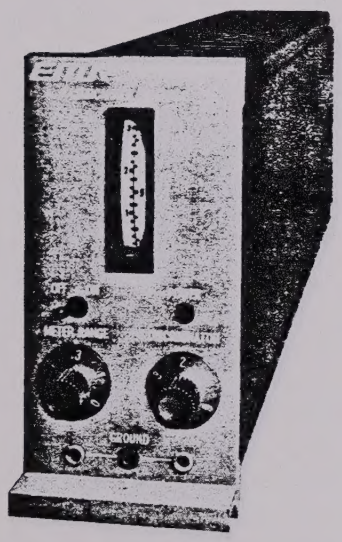
Electro-Mechanical Research, Inc.
Sarasota, Florida
January 1965

ME 3550

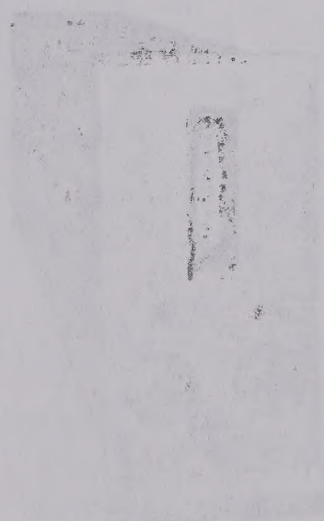
INSTRUCTION MANUAL

EMR MODELS 223B AND 223G
SOLID-STATE POWER SUPPLY

Revision E



Electro-Mechanical Research, Inc.
Sarasota, Florida
January 1965



ME3550

INSTRUCTION MANUAL

EMR MODELS 223B AND 223G
SOLID-STATE POWER SUPPLY

Revision E

Electro-Mechanical Research, Inc.
Sarasota, Florida
January 1965

TABLE OF CONTENTS

Section		Page
1	INTRODUCTION	1-1
	1.1 General	1-1
	1.2 Description	1-1
	1.2.1 Model 223B Power Supply	1-1
	1.2.2 Model 223G Power Supply	1-1
2	FUNCTION AND SPECIFICATIONS	2-1
	2.1 Function	2-1
	2.2 Functional Description	2-1
	2.2.1 Models 223B and 223G Power Supplies	2-1
	2.3 Specifications	2-1
	2.3.1 Models 223B-01, 223G-01, and 223G-03 Power Supplies	2-1
	2.3.2 Models 223B-02, 223G-02, and 223G-04 Power Supplies	2-2
3	INSTALLATION AND OPERATION	3-1
	3.1 General	3-1
	3.2 Installation	3-1
	3.2.1 Unpacking	3-1
	3.2.2 Mounting	3-1
	3.2.3 Cooling	3-1
	3.2.4 Electrical Connections	3-1
	3.3 Operation	3-1
	3.3.1 Location and Function of Front Panel Controls and Indicators	3-1
	3.3.2 Operating Procedure	3-3
4	THEORY OF OPERATION	4-1
	4.1 General	4-1
	4.2 Rectifier Circuit	4-1
	4.3 Regulator Circuit	4-1
	4.4 Meter Circuit	4-4

(Revised 8/65)

TABLE OF CONTENTS (continued)

Section			Page
5	MAINTENANCE		5-1
	5.1	General	5-1
	5.2	Inspection	5-1
	5.3	Maintenance Procedures	5-1
	5.4	Performance Tests	5-1
	5.4.1	Ripple Test, Models 223B and 223G Power Supplies	5-3
	5.4.2	Regulation Test, Models 223B-01, 223G-01, and 223G-03 Power Supplies	5-3
	5.4.3	Regulation Test, Models 223B-02, 223G-02, and 223G-04 Power Supplies	5-4
	5.4.4	Output Impedance Test	5-4
	5.4.5	Current Limiter Test	5-5
	5.4.6	Meter Calibration, Model 223B Power Supply	5-6
	5.4.7	Meter Calibration, Model 223G Power Supply	5-6
	5.5	Voltage Measurements	5-7
	5.6	Repairs	5-7
6	REPLACEABLE PARTS LIST		6-1
	6.1	General	6-1

(Revised 8/65)

Section Number

LIST OF ILLUSTRATIONS

Figure Number	Title	Page
1-1	Model 223B Power Supply	iv
3-1	Heat Dissipation and Distribution	3-2
3-2	Controls and Indicators, Model 223B Power Supply Front Panel	3-5
3-3	Controls and Indicators, Model 223G Power Supply Front Panel	3-5
4-1	Block Diagram, Power Supply	4-2
4-2	Block Diagram, Regulator Assembly	4-3
4-3	Block Diagram, Meter Circuit	4-5
5-1	Output Impedance Test Setup	5-5
5-2	Component Locations, Power Supply	5-9
5-3	Component Locations, Main Card Assembly	5-10
5-4	Component Locations, Regulator Assembly	5-11
5-5	Component Locations, Input Meter Card	5-11
5-6	Component Locations, Switch Card	5-12
5-7	Component Locations, Rear Plate Assembly	5-12
5-8	Schematic Diagram, Model 223B Power Supply	5-13
5-9	Schematic Diagram, Model 223G Power Supply	5-14
5-10	Schematic Diagram, Regulator Assembly	5-15
5-11	Schematic Diagram, Input Meter Card	5-15

LIST OF TABLES

Table Number	Title	Page
3-1	Location and Function of Controls and Indicators	3-4
5-1	Test Equipment Required for Performance Tests	5-2
5-2	Transistor Voltages, Regulator Assemblies	5-8
5-3	Transistor Voltages, Input Meter Card	5-8
6-1	Parts List, Models 223B and 223G Power Supplies	6-2

Figure 1-1. Model 223B Power Supply

SECTION 1

INTRODUCTION

1.1 GENERAL

This manual contains information describing operation, theory and maintenance of the EMR Models 223B and 223G Power Supplies. The power supplies are instruments of solid-state modular design for use in FM telemetry and data recording systems.

The Models 223B and 223G Power Supplies are special purpose power supplies specifically designed to provide power for EMR modular subcarrier discriminator telemetry systems.

1.2 DESCRIPTION

The power supplies as illustrated on Figure 1-1 are designed to be mounted into a Model 222A Rack Adapter which occupies approximately 5-1/4 inches of panel height. The power supplies are guided into the rack adapter by anodized aluminum T-rails and occupy three modular widths in the rack adapter. For additional information pertaining to the rack adapter, reference should be made to the Model 222A Rack Adapter Instruction Manual.

1.2.1 Model 223B Power Supply

The Model 223B Power Supply has at its output two regulated and two unregulated voltages for application to the modular equipment which it supplies with power. In addition, it has provisions for selecting any one of six inputs to the system and monitoring the level of the selected input with the subcarrier amplitude meter on the front panel.

1.2.2 Model 223G Power Supply

The Model 223G Power Supply has at its output two regulated and two unregulated voltages for application to the modular equipment which it supplies with power. In addition, the power supply has a provision for monitoring the level of the input to the system with the subcarrier amplitude meter on the front panel.

SECTION 2

FUNCTION AND SPECIFICATIONS

2.1 FUNCTION

The function of the Models 223B and 223G Power Supplies is to accept an AC-voltage input from an AC line and generate regulated and unregulated DC outputs for application to equipment requiring DC voltages for power.

2.2 FUNCTIONAL DESCRIPTION

2.2.1 Models 223B and 223G Power Supplies

The Models 223B and 223G Power Supplies are regulated DC power sources designed for use with modular equipment requiring well regulated voltages for power. In addition, two unregulated voltages are available at the output.

The regulated output voltages are +17.5 volts and -17.5 volts. The unregulated voltages are -26 volts at 0.25 ampere and -105 volts at 0.02 ampere.

The power supplies consists of a triple-rectifier circuit formed from a three-winding secondary power transformer, full-wave diode bridge rectifiers and filter capacitors. The regulated output voltages are stabilized by high-gain degenerative regulator assemblies.

2.3 SPECIFICATIONS

2.3.1 Models 223B-01, 223G-01, and 223G-03 Power Supplies

A. Electrical Specifications.

(1) Input Voltage: 120 volts ±12 volts, 47 to 420 CPS.

(2) Unregulated Output Voltages: -26 volts ±1 volt at 0.25 ampere and -105 volts ±5 volts at 0.02 ampere.

(3) Percent Ripple: RMS ripple is less than 6 percent of the DC supply voltage at full load for the -26-volt supply and less than 15 percent of the DC supply voltage for the -100-volt supply.

(4) Regulated Output Voltages: +17.5 volts and -17.5 volts ±0.87 volt at 1.5 amperes.

(Revised 8/65)

(5) Regulation: Regulated output will not change more than ±0.35 volt for any combination of line voltage and load current.

(6) Output Impedance: Less than 3 ohms from DC to 300 Kc.

(7) Output Ripple: Ripple appearing on DC output is less than 0.15 volt RMS at maximum rated load.

(8) Current Limiting: Limited internally at 2 amperes.

B. Mechanical Specifications.

(1) Height: 5 - 1/4 inches

(2) Width: 2 - 1/2 inches (3 modular widths)

(3) Depth: 15 - 1/2 inches

(4) Weight: 11 pounds

2.3.2 Models 223B-02, 223G-02, and 223G-04 Power Supplies

A. Electrical Specifications

(1) The electrical specifications are identical to the Models 223B-01 and 223G-01 with the following exception:

a. Input Voltage: 230 volts ±23 volts, 47 to 420 CPS.

B. Mechanical Specifications

(1) The mechanical specifications are identical to the Models 223B-01 and 223G-01 Power Supplies.

SECTION 3

INSTALLATION AND OPERATION

3.1 GENERAL

This section contains the installation procedures, location and function of front panel controls and indicators and procedures necessary for operation of the power supplies.

3.2 INSTALLATION

3.2.1 Unpacking

The power supply is shipped with all chassis covers and printed-circuit cards, as required, in place. The mating connector for the power supply is contained in the Model 222A Rack Adapter. Associated modular equipment such as rack adapters and test adapters are packaged separately. Any shortages or damage to the equipment should be reported in accordance with the instructions of the EMR Purchase Order Acknowledgment (POA).

3.2.2 Mounting

The power supply is mounted in the extreme left position of the rack adapter. The modular unit slides into this position guided by pre-positioned guide rails in the rack adapter and latches into a slotted rail at the bottom. Rack adapters are assembled and wired in accordance with customer requirements.

3.2.3 Cooling

The total heat dissipation and distribution for the power supply is shown on Figure 3-1. Grilles for natural convection or forced-air cooling are provided in the top and bottom covers. Adequate cooling must be provided to limit the ambient operating temperature to a maximum of 50 degree centigrade. Complete cooling instructions are provided in the Model 222A Rack Adapter Instruction Manual.

3.2.4 Electrical Connections

External connections to the power supply are made through the rear connector P1 (Amphenol type 133-022-23). Terminal assignments for this connector are shown on the schematic diagram for the power supply (Refer to Section 5).

3.3 OPERATION

3.3.1 Location and Function of Front Panel Controls and Indicators

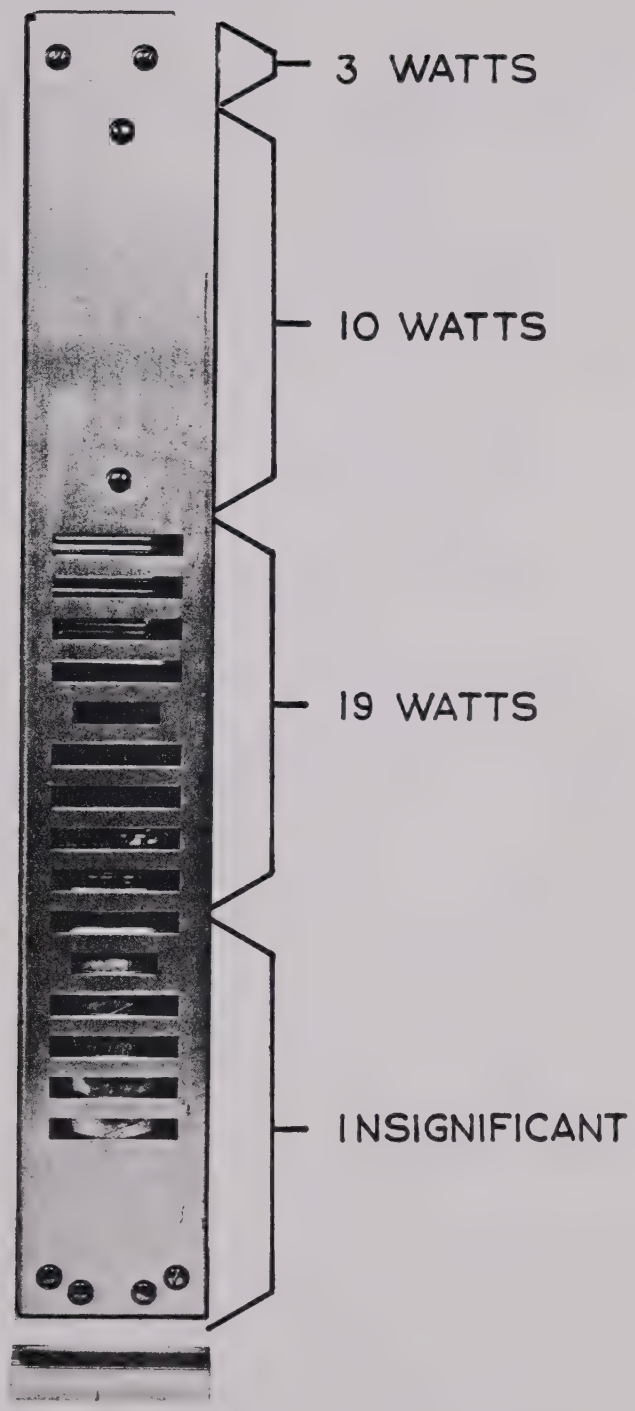


Figure 3-1. Heat Dissipation and Distribution

The front panel controls and indicators of the power supplies are described in Table 3-1. Figures 3-2 and 3-3 are used in conjunction with Table 3-1 to clarify the location of the tabulated components.

The Model 223B Power Supply front panel is illustrated on Figure 3-2 and the Model 223G Power Supply front panel is illustrated on Figure 3-3.

3.3.2 Operating Procedure

To operate the power supply, the power ON/OFF switch must be set to ON. The POWER lamp will light, indicating that power is applied to the system.

Table 3-1. Location and Function of Controls and Indicators (Refer to Figures 3-2 and 3-3)

	NAME	NOMEN-CLATURE	SETTINGS	TYPE	FUNCTION
1	METER RANGE	S101	0/.1/.3/1/3/10	Grayhill 45001-6	Provides full-scale meter ranges of 0.1, 0.3, 1.0, 3.0 and 10 volts for the SUBCARRIER AMPLITUDE meter.
2	OFF-ON power	S1	ON/OFF	Control Switch T2106	In ON position, power is applied to the system.
3	SUBCARRIER	M1	--	EMR 223-1035	Measures amplitude of the subcarrier signal at the output of the discriminator bandpass input filter but referenced to the subcarrier signal amplitude at the input to the discriminator at center frequency. Meter has five ranges: 0.1, 0.3, 1.0, 3.1 and 10.0 volts; meter indication is accurate to ±5% of full scale.
4	POWER indicator lens (red)	DS1	--	Eldema CFW	Illuminates when power is applied to the system.
5	DISCRIMINATOR	S102	1/2/3/4/5/6	Grayhill 45001-6	Connectos the SUBCARRIER AMPLITUDE meter to the discriminator selected. (Used on Model 223B Power Supply only.)
6	GROUND test jack (3)	TP1, TP2, TP3	--	Sealectro SKT-8	Test-point jacks.

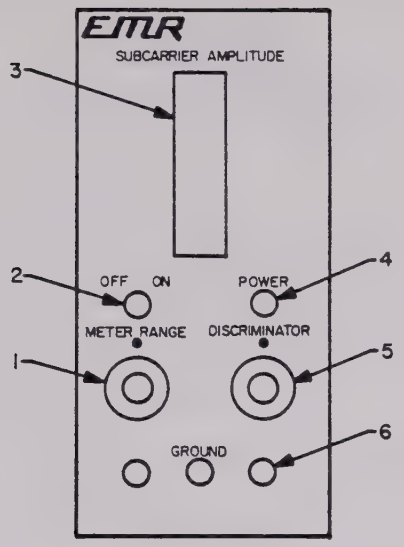


Figure 3-2. Controls and Indicators, Model 223B Power Supply Front Panel (Ref. Table 3-1).

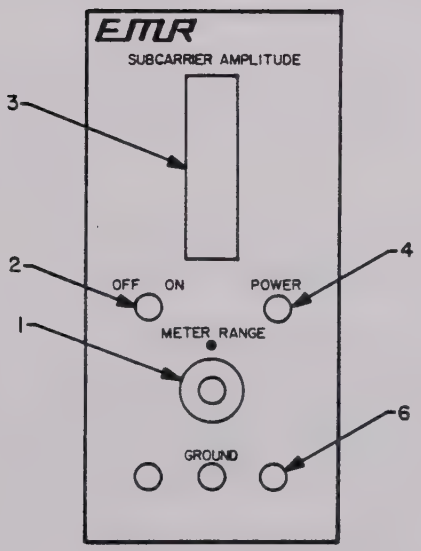


Figure 3-3. Controls and Indicators, Model 223G Power Supply Front Panel (Ref. Table 3-1).

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

This section provides the theory of operation for the Models 223B and 223G Power Supplies. The two power supplies are identical except for the DISCRIMINATOR select switch on the front panel of the Model 223B; therefore, only one description is contained in this section. The power supply circuits are broken down into three sections as shown on Figure 4-1, and a discussion of each section is presented in the following paragraphs.

Block diagrams in this section and schematic diagrams in Section 5 are supplied to supplement the theory of operation; reference to both should be made during the discussion of each power supply section.

4.2 RECTIFIER CIRCUIT

The rectifier circuit consists of a three-secondary power transformer, full-wave diode bridge rectifiers and filter circuits.

The AC single-phase input voltage is applied to transformer T1 through ON/OFF switch S1 on the front panel. Transformer T1 applies the line voltage to the full-wave triple-rectifier circuit consisting of silicon diodes CR1 through CR12. Filtering of the rectifier output is provided by capacitors C1 through C4. Resistors R2 through R5 are bleeder and minimum load resistors.

Two unregulated outputs of the rectifier circuit are wired directly to the power supply output plug P1, and two outputs are routed to the regulator circuits.

4.3 REGULATOR CIRCUIT

The regulator circuit consists of two high-gain degenerative series regulator assemblies. The block diagram of the regulator assembly is shown on Figure 4-2.

Each regulator accepts an unregulated DC voltage output from the rectifier circuit. The positive and negative regulators generate positive and negative regulated DC voltage outputs respectively. Both outputs are applied to power supply output plug P1 and to POWER indicator lamp DS1 on the front panel. Indicator lamp DS1 illuminates when power is applied to the system.

Regulation is accomplished in the series regulators by comparing a fixed fraction of the output voltage with a constant voltage reference. The sample of the output voltage is obtained from the center tap of potentiometer R11. Potentiometer R11 is also used to adjust the output voltage to the desired value. The constant reference voltage is obtained across zener-diode CR4. Any difference in output voltage is detected and amplified by a comparison amplifier formed by transistors

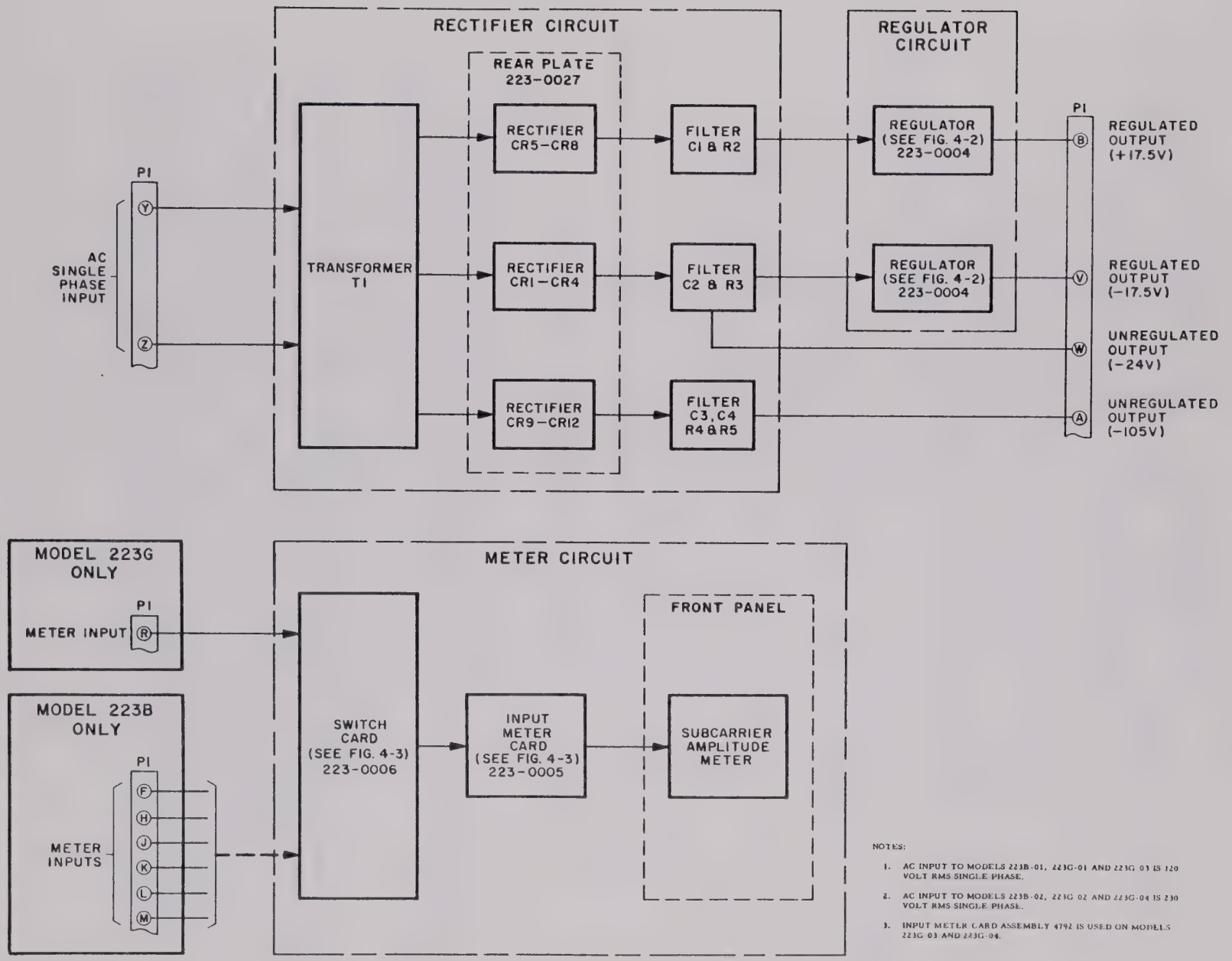


Figure 4-1. Block Diagram, Power Supply

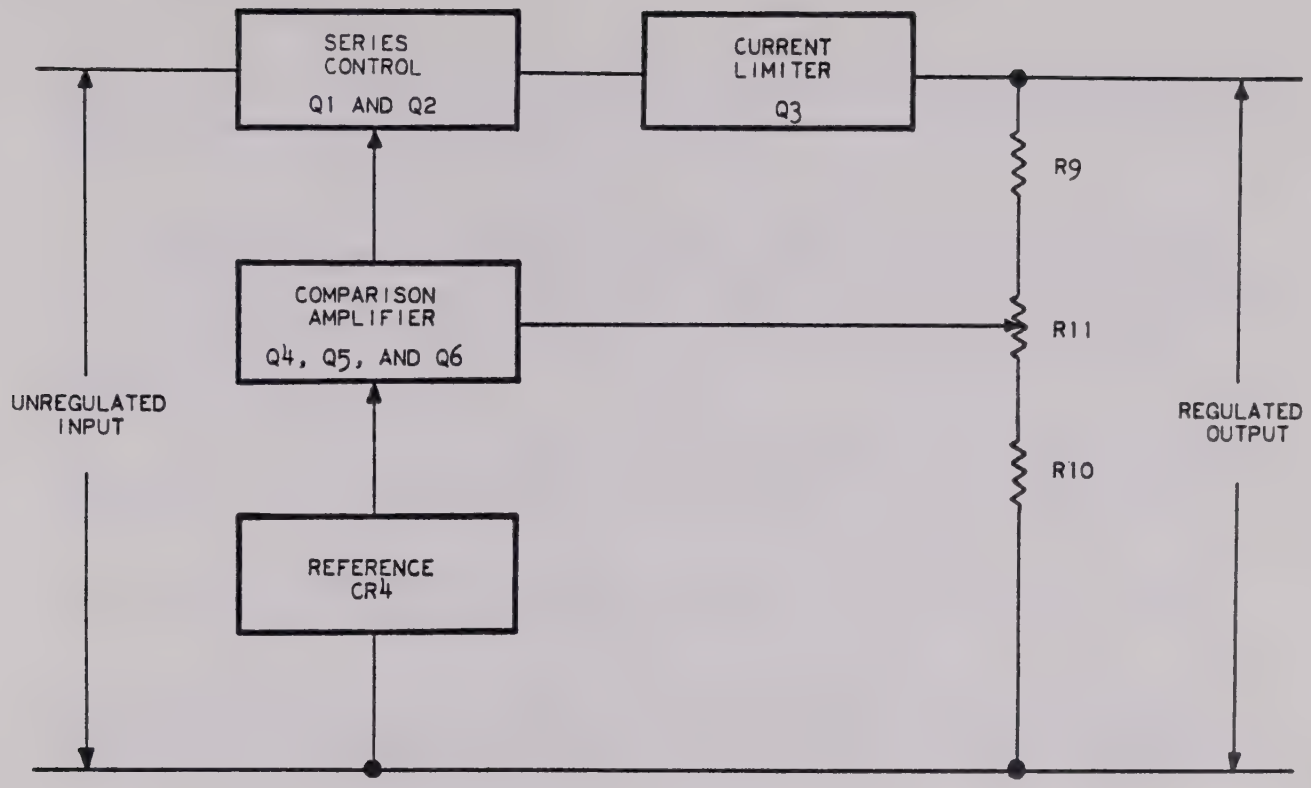


Figure 4-2. Block Diagram, Regulator Assembly

Q4, Q5 and Q6 in a differential connection. A series control circuit composed of transistors Q1 and Q2 senses the magnitude and direction of the amplified difference and changes the output voltage in the direction which tends to minimize voltage changes.

Current supplied to the load by the regulating action is limited by current limiter transistor Q3. Transistor Q3 is normally biased off by the voltage drop developed across forward-biased diode CR2. If sufficient load current is drawn through resistor R1, Q3 may become forward biased and provide partial base current for the series control. This action partially removes the comparison amplifier control and results in a drop of the output voltage. Further increases in load current will increase the forward-biasing of Q3 until Q3 is saturated. With Q3 saturated, the comparison amplifier no longer has any control; for Q3 suppies base current to the series control proportional to the load current, and further increases in load current are impossible.

4.4 METER CIRCUIT

The meter circuit consists of a switch card, input meter card and subcarrier amplitude meter as shown on Figure 4-1. A more detailed block diagram of the meter circuit is illustrated on Figure 4-3.

The subcarrier inputs to Model 223B Power Supply are routed from pins F, H, J, K, L and M of power supply plug P1 to pins 1 through 6 respectively of front panel DISCRIMINATOR select switch S102. Switch S102 is provided for selecting any one of six signal inputs for application to the meter circuit. The selected signal output of switch S102 is applied to pin 1 of METER RANGE switch S101 located on the front panel.

The subcarrier input to the meter circuit of Model 223G Power Supply is routed from pin R of power supply plug P1 to pin 1 of the front panel METER RANGE switch S101.

The operation of METER RANGE switch S101 and the remainder of the meter circuit is identical in both power supplies.

Subcarrier input attenuator circuits associated with METER RANGE switch S101 are selected as the amplitude of the input signal requires. Six meter ranges are available for input voltages ranging from 0.1-volt full-scale meter deflection to +10-volt meter deflections.

The attenuated subcarrier input signal is applied from the wiper arm of METER RANGE switch S101 through input capacitor C105 on the input meter card to the base of transistor Q101. Transistors Q101 and Q102 are a differential pair, the base of Q102 being the second input. Transistor Q103 is an emitter-follower for coupling the output of the first amplifier stage to the second stage, transistors Q104 and Q105. The output of the amplifier (collector of Q104) is coverted into a direct current in diodes CR101, CR102 and resistor R118. On the positive half-cycle of the output, current flows through CR101, the front panel SUB-CARRIER AMPLITUDE meter and R118. On the negative half-cycle, current is shunted around the meter through R118 and CR102. Thus, the current through the meter is in half sine-wave pulses; the current through R118 is a sine wave. The voltage drop across R118 is coupled through C111 to the base of Q102; due to the differential nature of Q101 and Q102, it must be the same as the voltage on the base of Q101. Since the current through the meter is exactly half the current through R118, and the voltage drop across R118 due to this current is exactly the same as the input signal, the meter indication is proportional to the input signal.

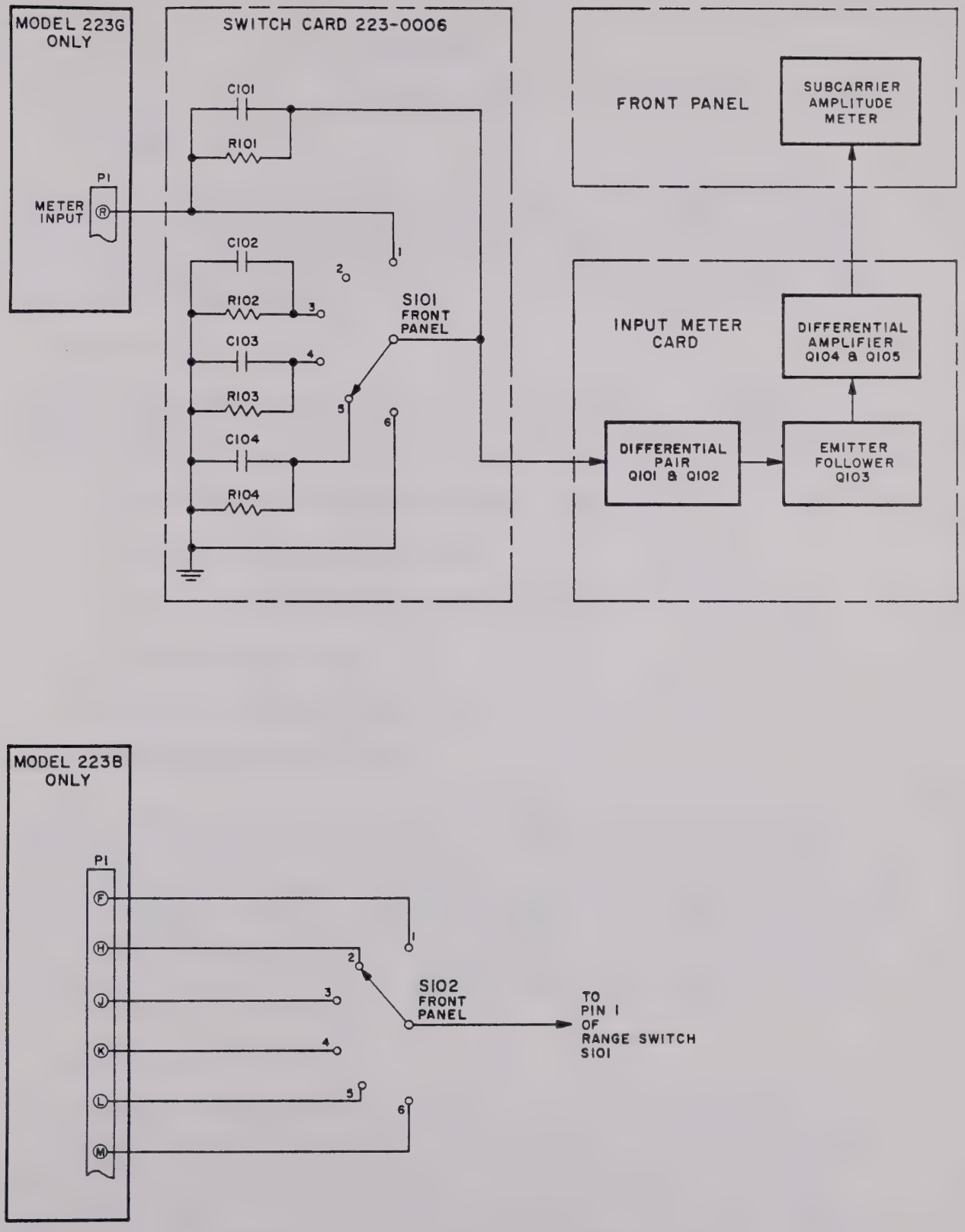


Figure 4-3. Block Diagram, Meter Circuit

SECTION 5

MAINTENANCE

5.1 GENERAL

This section contains information to assist personnel in troubleshooting and maintenance of the Models 223B and 223G Power Supplies. The material contained in this section supplements the theory of the modular unit functions described in Section 4, Theory of Operation, so that maintenance may be performed with maximum efficiency.

5.2 INSPECTION

The power supply should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. A periodic inspection shall include the following:

a. Inspection of all connectors for signs of damage.

b. Tightening of all external screws.

c. Inspection of all wiring for loose connections.

d. Checking performance.

e. Replacing defective components.

5.3 MAINTENANCE PROCEDURES

The power supply is a precision instrument which has been designed for long component life. If an abnormal indication is detected in the unit, reference should be made to the applicable block diagram in Section 4 and schematic diagrams (Figures 5-8 through 5-11) in this section for troubleshooting purposes. Component location diagrams are shown on Figures 5-2 through 5-7 for locating specific components. A component designation number corresponding to the electrical component shown on the schematic diagrams is permanently stamped opposite each component. Diode or transistor replacement should correct a majority of failures which develop.

5.4 PERFORMANCE TESTS

Proper operation of the power supply is vital to the optimum performance of the ground telemetry systems in which this unit is used. Abnormal operation of the power supply may cause the system to drift out of calibration or to operate in an erratic manner. The power supply performance may be determined by performing the tests outlined in this section. These tests attempt to isolate as many difficulties as possible with a minimum of equipment. Table 5-1

Table 5-1. Test Equipment Required for Performance Tests

APPLICATION	NAME	TYPE
Ripple Test	Oscilloscope	Hewlett-Packard 130B
	Resistors	Calculated to draw proper current at rated output voltage.
	Volt Box	Superior Electric Type UCIM
	VTVM	Hewlett-Packard Company 400D
Regulation Test	Differential DC Voltmeter	John Fluke Model 801
	Multimeter	Simpson Model 260
	Oscilloscope	Hewlett-Packard 130B
	Volt Box	Superior Electric Type UCIM
Output Impedance Test	VTVM	Hewlett-Packard Company 400D
	Capacitor	8 μf, non-polar
	Resistors	(2) 18 ohm, 25W; 1K, 1/4W
	Audio Oscillator	Hewlett-Packard Company 200CD
	Volt Box	Superior Electric Type UCIM
Current Limiter Test	Differential DC Voltmeter	John Fluke Model 801
	Multimeter	Simpson Model 260
	Resistors	Calculated to draw 4 amperes at rated output voltage.
	Volt Box	Superior Electric Type UCIM
Meter Calibration Test	Audio Oscillator	Hewlett-Packard Company 200CD
	VTVM	Hewlett-Packard Company 400D

lists recommended test equipment and test components necessary to perform the tests contained in the following paragraphs.

5.4.1 Ripple Test, Models 223B and 223G Power Supplies

a. Load power supply with resistors calculated to draw 1.5 amperes at rated output voltage.

b. Supply applicable line voltage (120-volt or 230-volt; see Section 2 for proper AC input voltage of unit) to the power supply from Volt Box. Measure line voltage with VTVM.

c. Measure ripple output from positive and negative supplies with oscilloscope and VTVM. Ripple output should be as specified in Section 2, Function and Specifications.

5.4.2 Regulation Test, Models 223B-01, 223G-01, and 223G-03 Power Supplies.

a. Supply 132-volt RMS line voltage to power supply from Volt Box. Measure line voltage with VTVM.

b. Measure output from positive and negative supplies with Differential DC Voltmeter. Record indication.

c. Load power supply with resistors calculated to draw 1.5 amperes at rated output voltage.

d. Supply 108-volt RMS line voltage to power supply from Volt Box. Measure line voltage with VTVM.

e. Measure output of the positive and negative supplies with Differential DC Voltmeter. Record indication.

f. Load power supply with resistors calculated to draw 0.5 ampere.

g. Supply 120-volt RMS line voltage to power supply from Volt Box. Measure line voltage with VTVM.

h. Measure output of the positive and negative supplies with Differential DC Voltmeter. Record indication.

i. Regulation is the difference between indications recorded in Steps b and e divided by indication recorded in Step h. Result will be less than or equal to the specification listed for the power supply being tested.

5.4.3 Regulation Test, Models 223B-02, 223G-02, and 223G-04 Power Supplies.

a. Supply 253-volt RMS line voltage to power supply from Volt Box. Measure line voltage with VTVM.

b. Measure output from positive and negative supplies with Differential DC Voltmeter. Record indication.

c. Load power supply with resistors calculated to draw 1.5 amperes at rated output voltage.

d. Supply 207-volt RMS line voltage to power supply from Volt Box. Measure line voltage with VTVM.

e. Measure output from positive and negative supplies with Differential DC Voltmeter. Record indication.

f. Load power supply with resistors calculated to draw 0.5 ampere at rated output voltage.

g. Supply 230-volt RMS line voltage to power supply from Volt Box. Measure line voltage with VTVM.

h. Measure output from positive and negative supplies with Differential DC Voltmeter. Record indication.

i. Regulation is the difference between indications recorded in Steps b and e divided by indication recorded in Step h. Result will be less than or equal to the specification listed for the power supply being tested.

5.4.4 Output Impedance Test

a. Connect the output impedance test setup as shown on Figure 5-1.

NOTE

In performing this test it is important that lead lengths be as short as possible.

b. Supply applicable line voltage (120-volt or 230-volt; see Section 2 for proper AC input voltage of unit) to the power supply from Volt Box. Measure line voltage with VTVM.

c. Supply 2 volts RMS to the circuit from the Signal Generator.

d. Measure V out and V in for each power supply at 10 CPS, 30 Kc and 300 Kc. Output impedance (Zo) for each frequency is calculated by the formula shown on Figure 5-1.

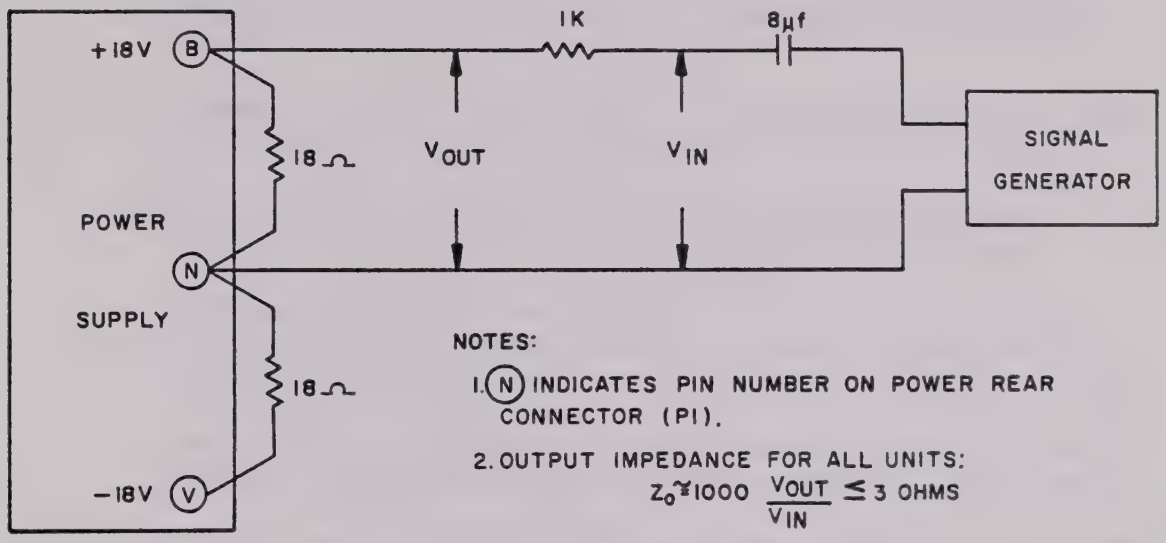


Figure 5-1. Output Impedance Test Setup

5.4.5 Current Limiter Test

a. Load power supply with resistors calculated to draw 4.0 amperes at rated output voltage (overloaded condition).

b. Supply applicable line voltage (120-volt or 230-volt; see Section 2 for proper AC input voltage of unit) to the power supply from Volt Box. Measure line voltage with VTVM.

c. Measure load current and voltage with Multimeter and Differential DC Voltmeter. Load current should be between 1.5 and 2 amperes. Output voltage should be near zero volts. (This indicates that current limiter is operating properly.)

d. Remove load from power supply.

e. Measure output voltage with Differential DC Voltmeter. Output voltage will return to normal.

5.4.6 Meter Calibration, Model 223B Power Supply

a. Set METER RANGE switch to .3 position. Connect Audio Oscillator input to pin F of rear connector P1. Adjust audio oscillator output level to 150 millivolts at a frequency of 300 CPS.

b. Set DISCRIMINATOR switch to 1. Input meter should indicate full scale.

c. Connect oscillator input to pin H of connector P1. Set DISCRIMINATOR switch to 2. Input meter should indicate full scale.

d. Repeat Step c for pins J, K, L, and M on connector P1 with DISCRIMINATOR switch set to 3, 4, 5 and 6 respectively.

e. With METER RANGE switch set to .3 position and oscillator frequency at 1 Kc, adjust oscillator amplitude until input meter indicates full scale. Input voltage should be 150 millivolts ±2%.

f. Set oscillator frequency to 300 Kc. Adjust C106A so that oscillator level is 150 millivolts ±2% when input meter indicates full scale.

g. Check accuracy of remaining 5 positions of METER RANGE switch. At each position, adjust oscillator input voltage to one-half of full-scale voltage ±2%. Check that this tolerance is maintained throughout the frequency range of 300 CPS to 300 Kc.

5.4.7 Meter Calibration, Model 223G Power Supply

a. Set METER RANGE switch S101 to .3 position. Connect Audio Oscillator input to pin R of rear connector plug P1. Adjust Audio Oscillator output level to 150 millivolts at a frequency of 1 Kc. Input meter should indicate full scale. If not, adjust C106A on input meter card until meter indicates full scale.

b. Check accuracy of remaining 5 positions of METER RANGE switch. At each position, adjust oscillator output voltage to one-half full-scale voltage ±2%.

c. At each position, check that this tolerance is maintained throughout the frequency range of 300 CPS to 300 Kc.

5.5 VOLTAGE MEASUREMENTS

All AC and DC measurements should be made with signal ground as reference. Access to test points is accomplished by removing power supply from the rack adapter and then removing the side cover of the power supply. The EMR Model 222B-01 Test Adapter may be used to extend the power supply from the rack adapter for easy access to test points.

During operation, access to the components on the printed-circuit cards may be gained by using Cheater Card (EMR part number 223-1060).

Tables of typical voltages (Tables 5-2 and 5-3) are provided to aid personnel in locating a defect within one of the regulator or input meter card stages. Voltage measurements may deviate considerably from those listed in the tables without indicating trouble but are typical of those measured at specific transistor stages.

5.6 REPAIRS

When a faulty component has been located, reference should be made to Section 6, Replaceable Parts List, for a complete description of the faulty part. After replacement of the faulty component, the performance test of the modular unit should be repeated to ascertain the malfunction has been corrected.

Table 5-2. Transistor Voltages, Regulator Assemblies

-18-VOLT REGULATOR			
TRANSISTOR	COLLECTOR (V)	BASE (V)	EMITTER(V)
Q1	-25	-18.8	-18.5
Q2	-25	-19	-18.8
Q3	-19	-17.8	-18
Q4	-19.2	-24.3	-24.5
Q5	-18	- 9.1	- 8.9
Q6	-19.2	- 9.1	- 8.9
+18-VOLT REGULATOR			
TRANSISTOR	COLLECTOR (V)	BASE (V)	EMITTER(V)
Q1	- 7.0	- 0.75	- 0.5
Q2	- 7.0	- 1.0	- 0.75
Q3	- 1.0	0.2	0
Q4	- 1.2	- 5.5	- 5.7
Q5	0	8.9	9.1
Q6	- 1.2	8.9	9.1

Table 5-3. Transistor Voltages, Input Meter Card

METER AMPLIFIER CARD			
TRANSISTOR	COLLECTOR (V)	BASE (V)	EMITTER (V)
Q101	-9.9	-6.0	-5.8
Q102	-18.0	-6.0	-5.8
Q103	-18.0	-9.9	-9.7
Q104	-14.5	-9.7	-9.5
Q105	-18.0	-9.7	-9.5

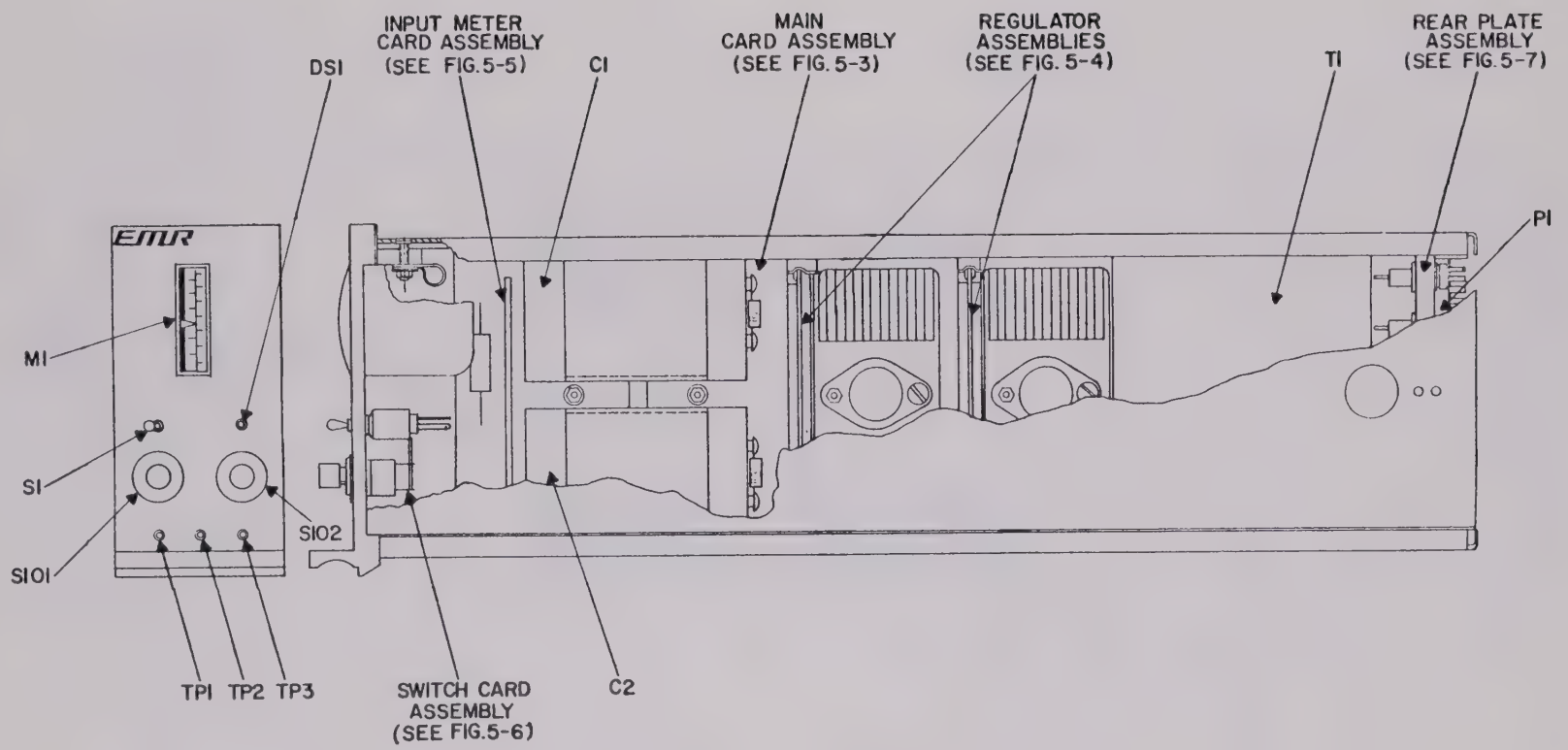


Figure 5-2. Component Locations, Power Supply

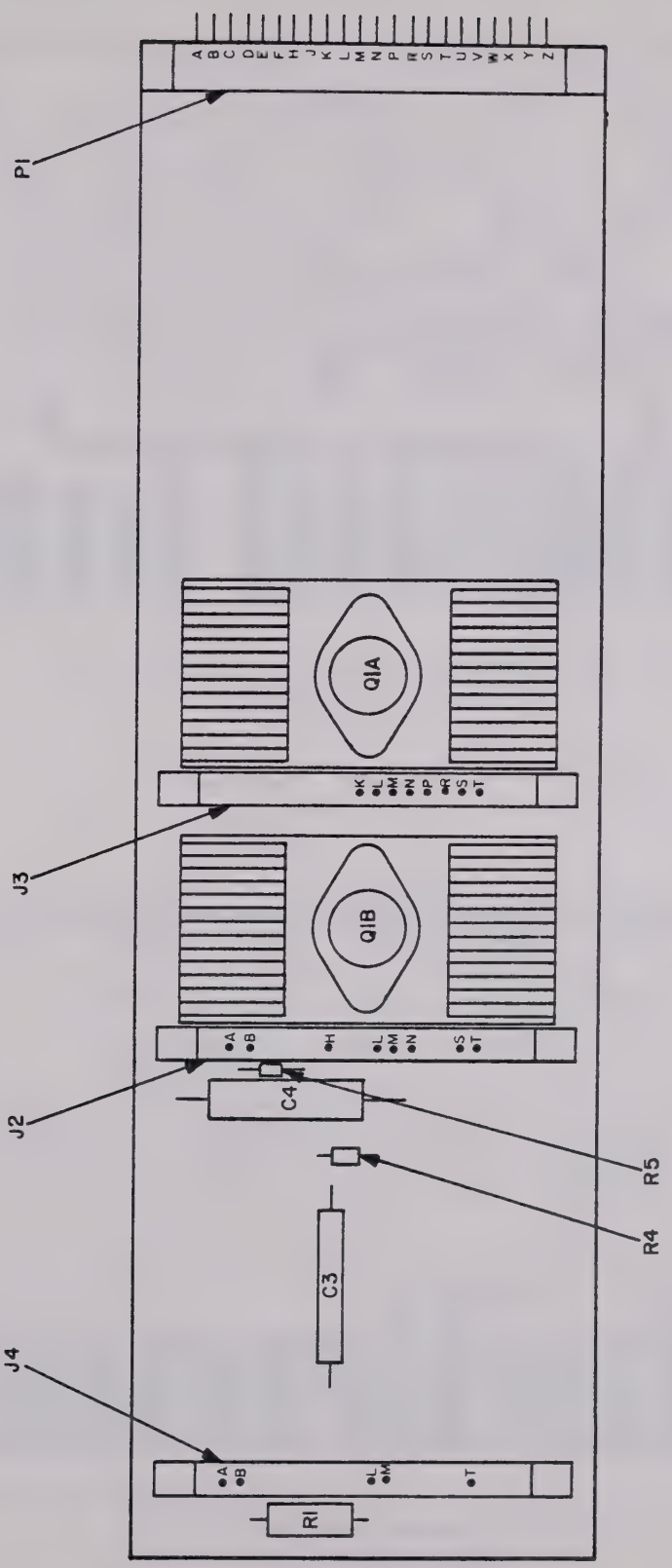


Figure 5-3. Component Locations, Main Card Assembly

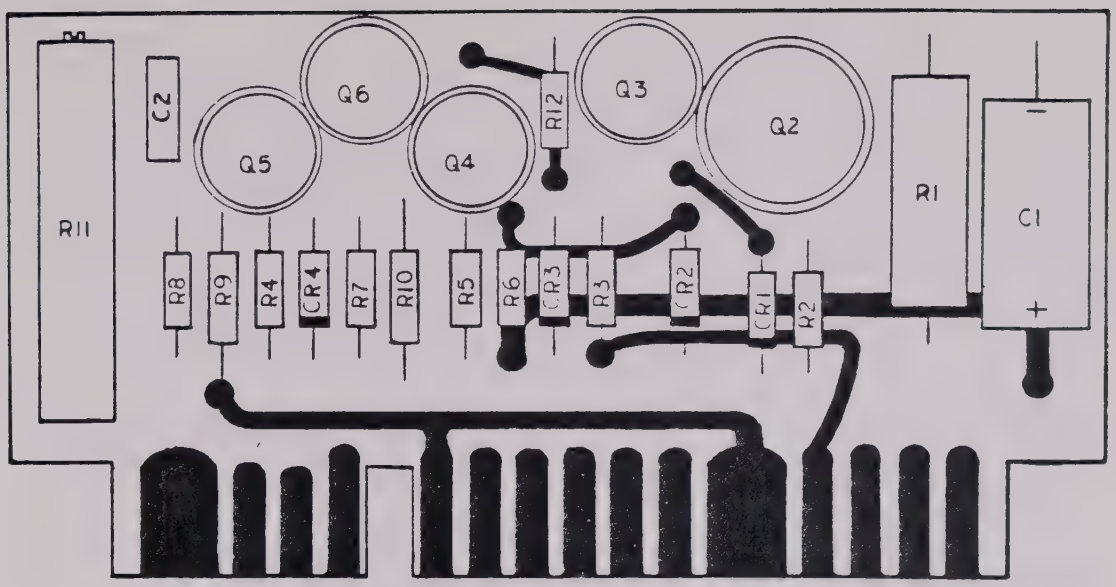
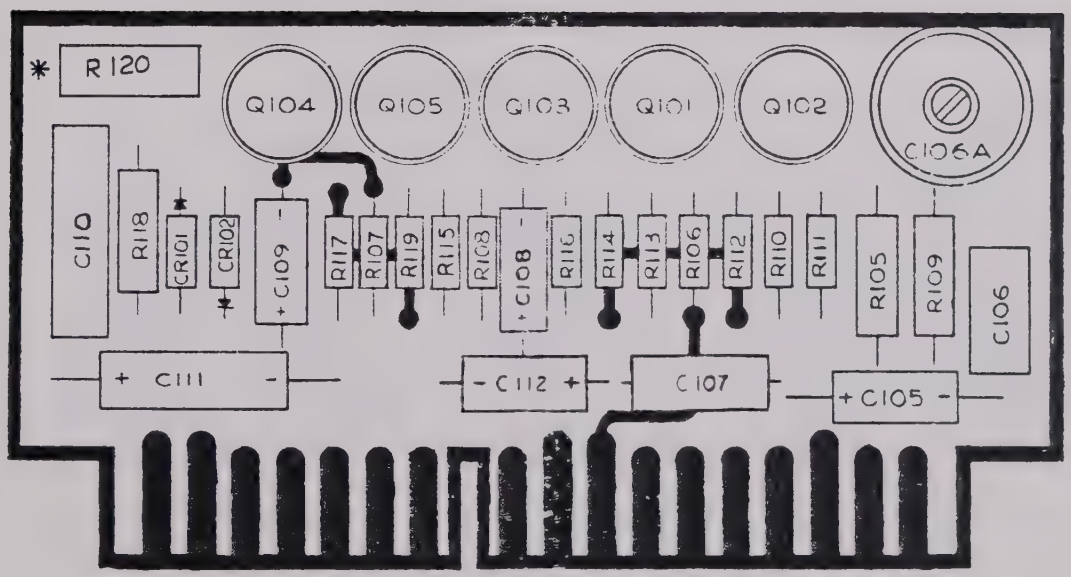


Figure 5-4. Component Locations,
Regulator Assembly



*USED ON MODELS 223C-03 AND 223C-04 ONLY.

Figure 5-5. Component Locations,
Input Meter Card

(Revised 8/65)

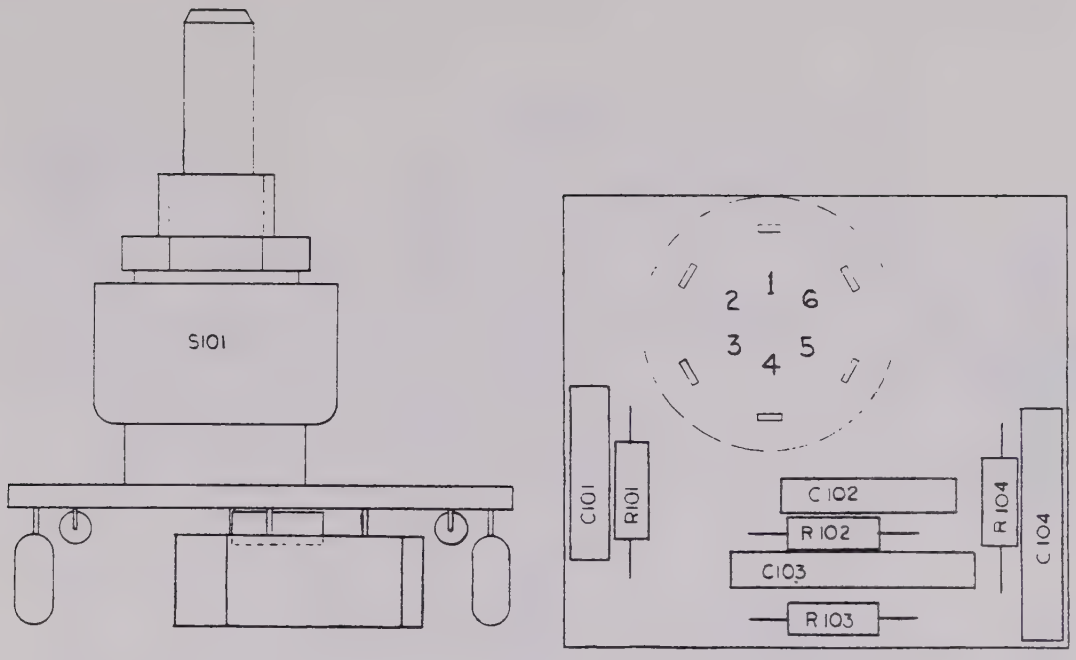


Figure 5-6. Component Locations, Switch Card

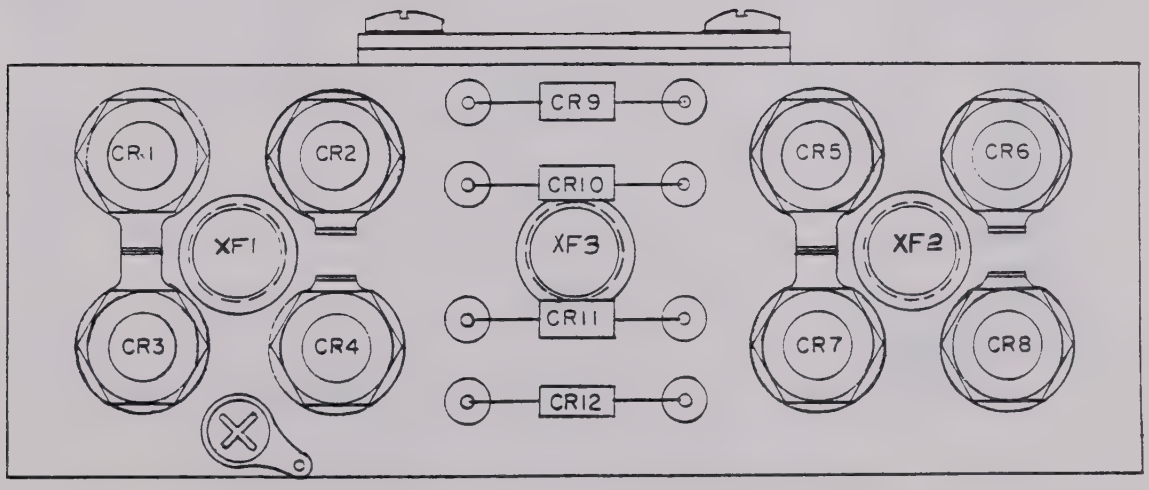


Figure 5-7. Component Locations, Rear Plate Assembly

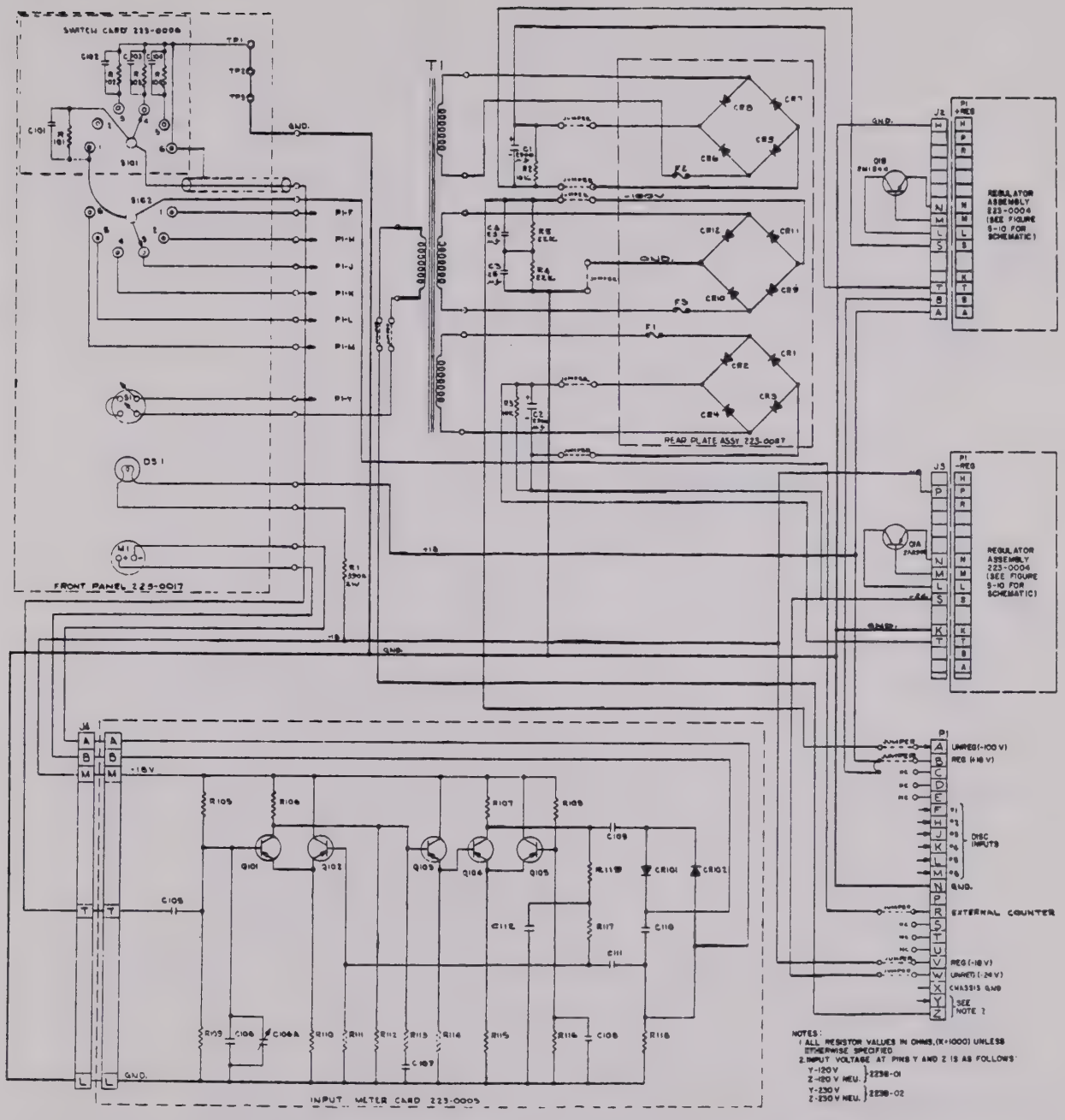

SWITCH CARD 223-0006
FRONT PANEL 223-0017
REAR PLATE ASSY 223-0007
REGULATOR ASSEMBLY 223-0004 (SEE FIGURE 5-10 FOR SCHEMATIC)
INPUT METER CARD 223-0005
GND.
-18V
+18
-100V
DISC INPUTS
EXTERNAL COUNTER
NOTES:
1 ALL RESISTOR VALUES IN OHMS, (K=1000) UNLESS OTHERWISE SPECIFIED
2 INPUT VOLTAGE AT PINS Y AND Z IS AS FOLLOWS
Y-100V Z-100 V NEU. } 2238-01
Y-230 V Z-230 V NEU. } 2238-02

Figure 5-8. Schematic Diagram, Model 223B Power Supply

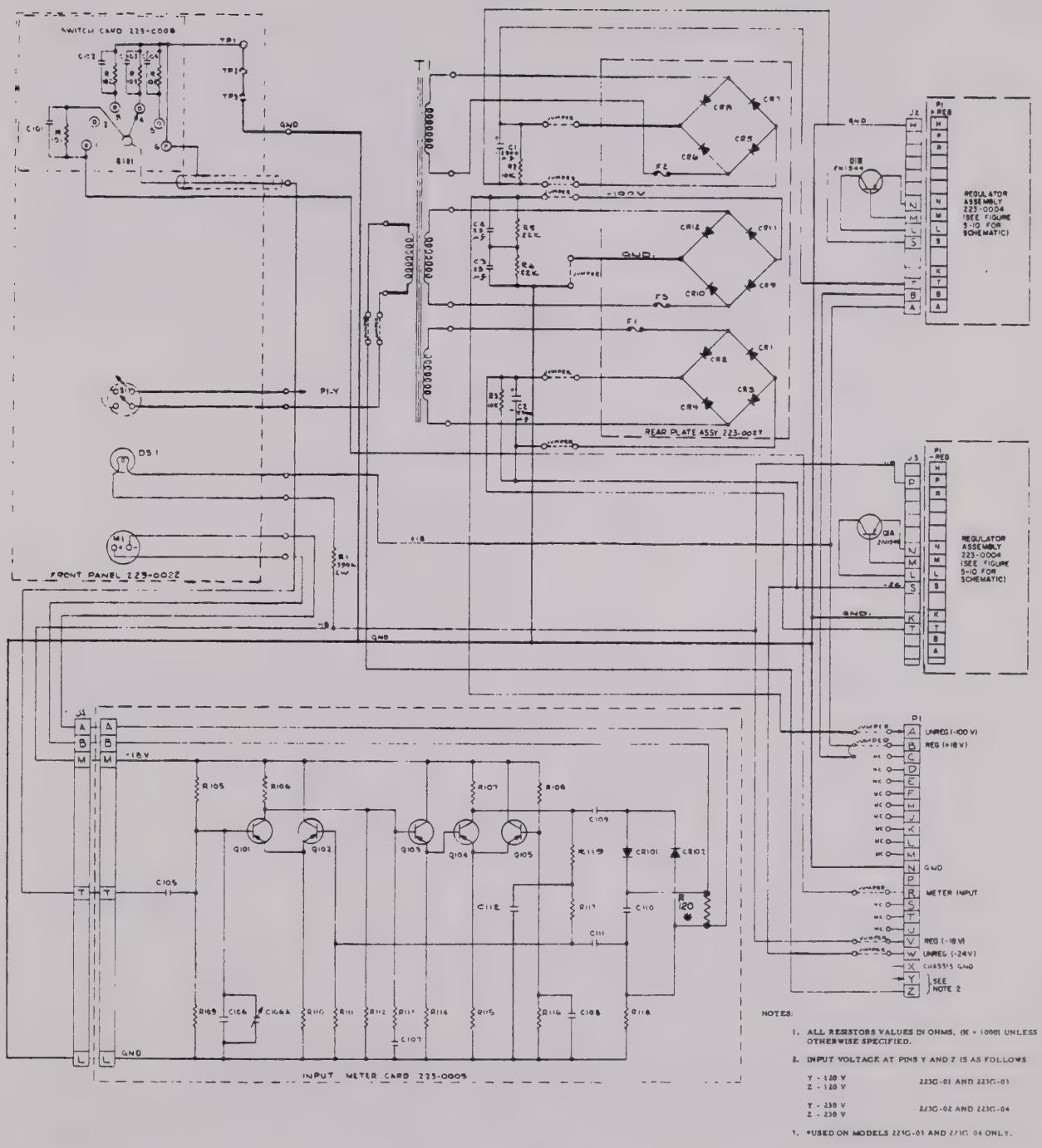

SWITCH CARD 223-0008
FRONT PANEL 223-0022
READ PLATE ASSY 223-0027
REGULATOR ASSEMBLY 223-0004 (SEE FIGURE 5-10 FOR SCHEMATIC)
REGULATOR ASSEMBLY 223-0004 (SEE FIGURE 5-10 FOR SCHEMATIC)
INPUT METER CARD 223-0005
GND
+18V
-18V
-100V
UNREG (-100 V)
REG (+18 V)
METER INPUT
REG (-18 V)
UNREG (-24V)
CHASSIS GND
NOTES:
1. ALL RESISTORS VALUES IN OHMS, (K = 1000) UNLESS OTHERWISE SPECIFIED.
2. INPUT VOLTAGE AT PINS Y AND Z IS AS FOLLOWS
Y - 120 V
Z - 120 V
223G-01 AND 223G-03
Y - 230 V
Z - 230 V
223G-02 AND 223G-04
1. *USED ON MODELS 223G-01 AND 223G-04 ONLY.

Figure 5-9. Schematic Diagram, Model 223G Power Supply

(Revised 8/65)

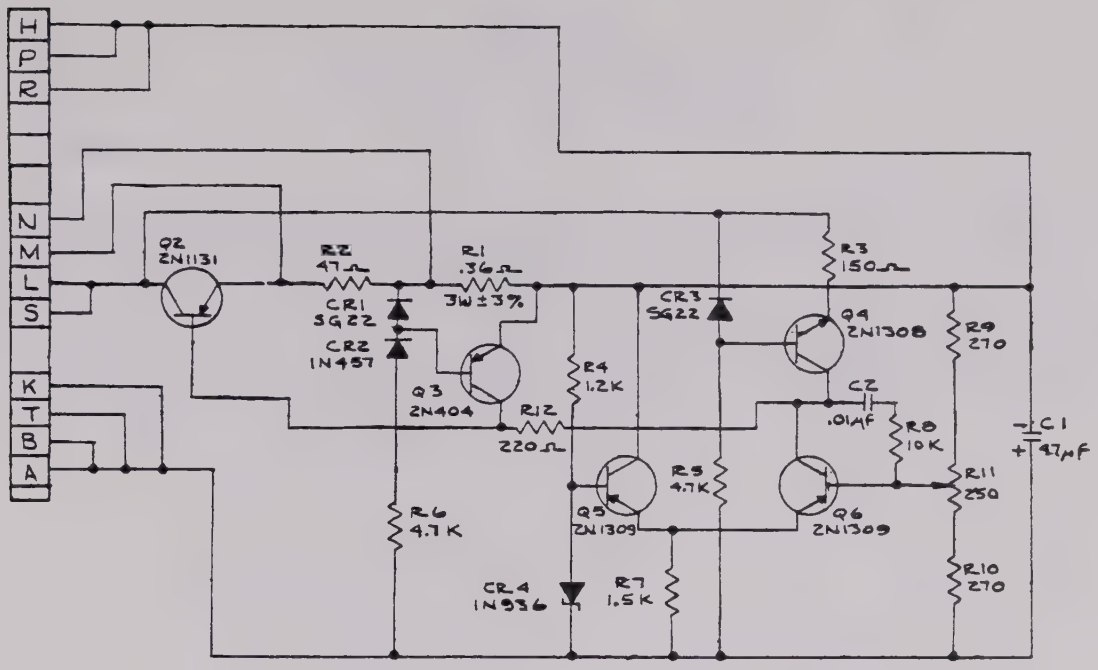
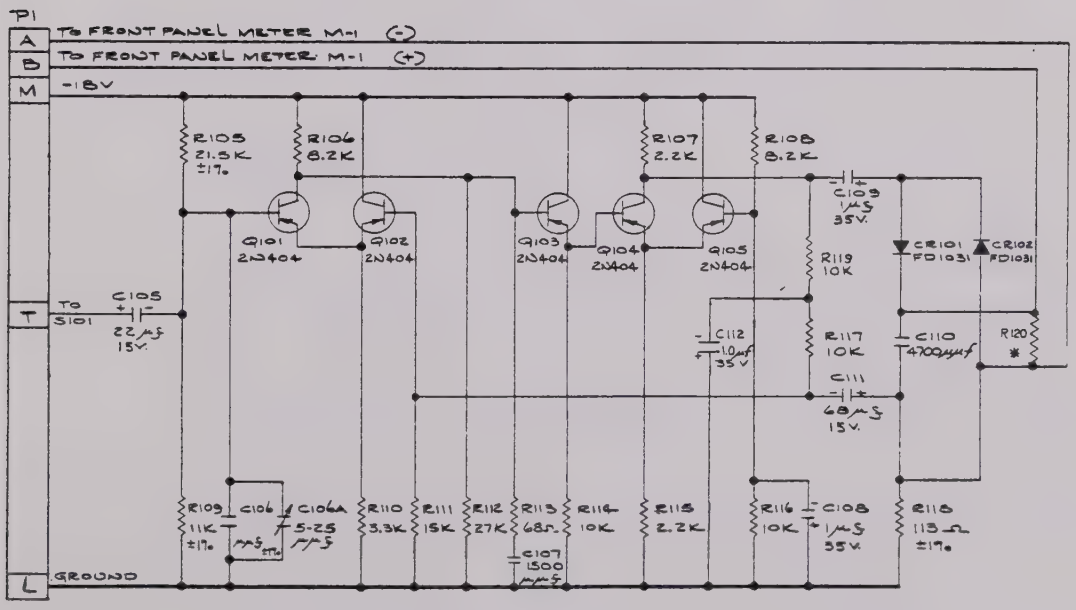


Figure 5-10. Schematic Diagram, Regulator Assembly



*USED ON MODELS 223G-03 AND 223G-04 ONLY.

Figure 5-11. Schematic Diagram, Input Meter Card

(Revised 8/65)

SECTION 6

REPLACEABLE PARTS LIST

6.1 GENERAL

This section contains information necessary to identify electronic components for the Models 223B and 223G Power Supplies. Parts information is presented in tabular form and is keyed to illustrations in Section 5 of this manual. The parts list table is broken down to the following columns: Circuit Symbol Number column identifies the particular part by its reference designation; the Description column gives a complete description of the item; the Manufacturer column gives the name and manufacturers' part number.

Table 6-1. Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
	POWER SUPPLY ASSEMBLY (Model 223B only)	EMR	223-0009
	POWER SUPPLY ASSEMBLY (Model 223G only)	EMR	2160
	FRONT PANEL ASSEMBLY (Used on Model 223B only)	EMR	223-0017
	FRONT PANEL ASSEMBLY (Used on Model 223G only)	EMR	223-0022
DS1	INDICATOR LAMP	Eldema	CFW2255 6-01
J2, J3 and J4	TEST JACK (White)	Sealectro	SKT-8
M1	SUBCARRIER AMPLITUDE METER	EMR	223-1035
S1	MINIATURE TOGGLE SWITCH	Control Switch	T2106
S102	MIDGET ROTARY SWITCH (Used on 223B only)	Grayhill or equiv.	45001-6
	SWITCH CARD ASSEMBLY	EMR	223-0006
C101	CAPACITOR, 47 μμf ±1%, 500V	Arco or equiv.	DM15-470F
C102	CAPACITOR, 350 μμf ±1%, 500V	Arco or equiv.	DM15-351F
C103	CAPACITOR, 1350 μμf ± 1%, 500V	Arco or equiv.	DM19-1351F
C104	CAPACITOR, 4850 μμf ±1%, 500V	Arco or equiv.	DM19-4851F

Table 6-1 (Cont'd.). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R101	RESISTOR, 14.7 K ±1%, 1/10W	IRC or equiv.	EM
R102	RESISTOR, 2.1 K ±1%, 1/10W	IRC or equiv.	EM
R103	RESISTOR, 549 ohm ±1%, 1/10W	IRC or equiv.	EM
R104	RESISTOR, 150 ohm ±1%, 1/10W	IRC or equiv.	EM
S101	MIDGET ROTARY SWITCH	Grayhill or equiv.	45001-6
	SWITCH CARD	EMR	223-1015
	INPUT METER CARD ASSEMBLY	EMR	223-0005
CR101 and CR102	DIODE	Fairchild or equiv.	FD1031
C105	CAPACITOR, 22 μf ±20%, 15V	Sprague or equiv.	150D226X 0015B2
C106	CAPACITOR, 1%, 500V (Value to be determined in test.)	Arco or equiv.	DM15
C106A	CAPACITOR, Trimmer, 5-25 μf, 350V	Erie	557-051C 0P039R
C107	CAPACITOR, 1500 μμf ±5%, 500V	Arco or equiv.	DM19-152J
C108, C109 and C112	CAPACITOR, 1 μf ±20%, 35V	Sprague	150D105X 0035A2
C110	CAPACITOR, 4700 μμf ±10%, 300V	Arco or equiv.	DM10-472K

Table 6-1 (Cont'd.). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
C111	CAPACITOR, 68 μf ±20%, 15V	Sprague or equiv.	150D686X 0015R2
Q101 thru Q105	TRANSISTOR	RCA or equiv.	2N404
R105	RESISTOR, 21.5 K ±1%, 1/8W	IRC or equiv.	MEA-TO
R106 and R108	RESISTOR, 8.2 K ±5%, 1/4W	Allen Bradley or equiv.	CB8225
R107 and R115	RESISTOR, 2.2 K ±5%, 1/4 W	Allen Bradley or equiv.	CB2225
R109	RESISTOR, 11 K ±1%, 1/8W	IRC or equiv.	MEA-TO
R110	RESISTOR, 3.3 K ±5%, 1/4W	Allen Bradley or equiv.	CB3325
R111	RESISTOR, 15 K ±5%, 1/4W	Allen Bradley or equiv.	CB1535
R112	RESISTOR, 27 K ±5%, 1/4W	Allen Bradley or equiv.	CB2735
R113	RESISTOR, 68 ohm ±5%, 1/4W	Allen Bradley or equiv.	CB6805
R114, R116, R117 and R119	RESISTOR, 10 K ±5%, 1/4W	Allen Bradley or equiv.	CB1035

Table 6-1 (Cont'd.). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R118	RESISTOR, 113 ohm ±1%, 1/8W	IRC or equiv.	MEA-TO
	MAIN CARD ASSEMBLY	EMR	223-0013
C3 and C4	CAPACITOR, 25 μf $^{-15\%}_{+30\%}$, 100V	Sprague	112D256 C3100J1
J2	CONNECTOR, Modified	EMR	223-1047
J3	CONNECTOR, Modified	EMR	223-1049
J4	CONNECTOR, Modified	EMR	223-1048
P1	CONNECTOR, Printed-Circuit	Amphenol	133-022-43
Q1A and Q1B	TRANSISTOR	Motorola or equiv.	2N1544
R1	RESISTOR, 390 ohm ±10%, 2W	Allen Bradley or equiv.	HB3911
R4 and R5	RESISTOR, 22 K ±10%, 1/4W	Allen Bradley or equiv.	CB2231
	CIRCUIT CARD	EMR	223-1025
	REGULATOR (18V) ASSEMBLY	EMR	223-0004
C1	CAPACITOR, 47 μf ±20%, 35V	Sprague	150D476X 0035S2
C2	CAPACITOR, 0.01 μf ±5%, 100V	Paktron	Type 330
CR1	DIODE	Transi-tron	SG-22

Table 6-1 (Cont'd.). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
CR2	DIODE	Transi-tron	1N457
CR3	DIODE	Transi-tron	SG-22
CR4	DIODE	Motorola	1N936
Q2	TRANSISTOR	RCA	2N1183A
Q3	TRANSISTOR	RCA	2N404
Q4	TRANSISTOR	Texas Inst.	2N1308
Q5	TRANSISTOR	Texas Inst.	2N1309
Q6	TRANSISTOR	Texas Inst.	2N1309
R1	RESISTOR, 0.5 ohm ±3%, 3W	Sage Elec.	S3W
R2	RESISTOR, 47 ohm ±10%, 1/4W	Allen Bradley or equiv.	CB4701
R3	RESISTOR, 150 ohm ±10%, 1/4W	Allen Bradley or equiv.	CB1511
R4	RESISTOR, 1.2 K ±10%, 1/4W	Allen Bradley or equiv.	CB1221
R5 and R6	RESISTOR, 4.7 K ±10%, 1/4W	Allen Bradley or equiv.	CB4721
R7	RESISTOR, 1.5 K ±10%, 1/4W	Allen Bradley or equiv.	CB1521

Table 6-1 (Cont'd.). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R8	RESISTOR, 10 K ±10%, 1/4W	Allen Bradley or equiv.	CB1031
R9 and R10	RESISTOR, 270 ohm ±5%, 1/4W	Allen Bradley or equiv.	CB2711
R11	POTENTIOMETER, 0-250 ohm ±10%, 1/4W	Allen Bradley or equiv.	RP102U
R12	RESISTOR, 220 ohm ±10%, 1/4W	Allen Bradley or equiv.	CB2211
	REAR PLATE ASSEMBLY	EMR	223-0027
CR1 thru CR8	DIODE	Texas Inst.	1N1124R
CR9 thru CR12	DIODE	Texas Inst.	1N646
F1 and F2	MICRO FUSE, 5 Amp, 125V	Littel Fuse	272005
F3	MICRO FUSE, 1/4 Amp, 125V	Littel Fuse	272000
XF1 thru XF3	FUSE HOLDER	Littel Fuse	282001
C1 and C2	CAPACITOR, 2900 μf ±20%, Type 320, 40V	Sprague	32D2126T
R2 and R3	RESISTOR, 10 K ±10%, 1/4W	Allen Bradley or equiv.	CB1031

Table 6-1 (Cont'd.). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
T1	TRANSFORMER (Used on Models 223B-01, 223G-01, and 223G-03 only)	EMR	990-0033
T1	TRANSFORMER (Used on Models 223B-02, 223G-02, and 223G-04 only)	EMR	990-0037
	INPUT METER CARD ASSEMBLY (Used on the Model 223G-03 and -04 only)	EMR	4792
	PRINTED-WIRING BOARD	EMR	4791
C105	CAPACITOR, 22 µf ±20%, 15 V	EMR601	601-226203
C106	CAPACITOR, ±1%, 500 V (Value to be determined in test.)	EMR600	600-
C106A	CAPACITOR, -var, 5-25 Pf, NPO, 350 V	Erie	557-051C 0P039R
C107	CAPACITOR, 1500 µµf ±5%, 500 V	EMR600	600-3415265
C108 & C109	CAPACITOR, 1.0 Uf ±20%, 35 V	EMR601	601-105207
C110	CAPACITOR, 4700 µµf ±10%, 300 V	EMR600	600-3447275
C111	CAPACITOR, 68 Uf ±20%, 15 V	EMR601	601-686203
C112	CAPACITOR, 1.0 Uf ±20%, 35 V	EMR601	601-105207
CR101 & CR102	DIODE	Fairchild	FD1031
Q101 thru Q105	TRANSISTOR (2N404)	EMR649	649

(Revised 8/65)

Table 6-1 (Cont'd). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R105	RESISTOR, 21.5 K ±1%, 1/8 W	EMR625	625-215231
R106	RESISTOR, 8.2 K ±5%, 1/4 W		RC07GF822J
R107	RESISTOR, 2.2 K ±5%, 1/4 W		RC07GF222J
R108	RESISTOR, 8.2 K ±5%, 1/4 W		RC07GF822J
R109	RESISTOR, 11 K ±1%, 1/8 W	EMR625	625-110231
R110	RESISTOR, 3.3 K ±5%, 1/4 W		RC07GF332J
R111	RESISTOR, 15 K ±5%, 1/4 W		RC07GF153J
R112	RESISTOR, 27 K ±5%, 1/4 W		RC07GF273J
R113	RESISTOR, 68 Ω ±5%, 1/4 W		RC07GF680J
R114	RESISTOR, 10 K ±5%, 1/4 W		RC07GF103J
R115	RESISTOR, 2.2 K ±5%, 1/4 W		RC07GF222J
R116 & R117	RESISTOR, 10 K ±5%, 1/4 W		RC07GF103J
R118	RESISTOR, 113 Ω ±1%, 1/8 W	EMR625	625-113031

Table 6-1 (Cont'd.). Parts List, Models 223B and 223G Power Supplies

CIRCUIT SYMBOL NO.	DESCRIPTION	MANUFACTURER	
		NAME	PART NO.
R119	RESISTOR, 10 K ±5%, 1/4 W		RC07GF 103J
R120	RESISTOR, 866 Ω ±1%, 1/8 W	EMR625	625-866031

(Revised 8/65)